The PPQ Weed Risk Assessment

Overview

Presented at
National Plant Board Meeting
Mystic, Connecticut
July 23-26, 2012

Who am I?

- Special Projects Coordinator for the PERAL Weed Team

  Plant Protection and Quarantine
  Center for Plant Health Science and Technology
  Plant Epidemiology and Risk Analysis Laboratory
  Raleigh, NC

- Risk analyst – Plant population biology

Our Mission

- Prepare weed risk assessments (WRA) in response to concerns about weed risk from customers
- Provide technical and resource support to colleagues and customers on weed and invasive plant issues
- Support PPQ's mission of plant protection by proactively identifying and assessing noxious weeds and pest plants of concern

What is Weed Risk Assessment?

WRA: An evaluation of the probability of the introduction and spread of a plant**,** and of the potential consequences, helping us to make informed management decisions that will reduce the economic and ecological harm caused by weedy and invasive plants

Our WRA process

Receive WRA request

Add to queue and determine priority/target date

Scientific review ↔ **WRA development**

Editorial review ↔ **WRA development**

Asst. Director review ↔ **WRA development**

WRA development → **WRA finalized and submitted to customers**

Revision requested → **WRA development**

Style of the assessment

- Mostly Yes/No questions; a few multiple choice
- Record uncertainty: negl, low, mod, high, max
- Evidence and supporting documents recorded for each

Risk Elements in the WRA

- Establishment / Spread Potential (23)
- Impact Potential (18)
- Geographic Potential (3/36)
- Entry Potential (14)

Predictive model

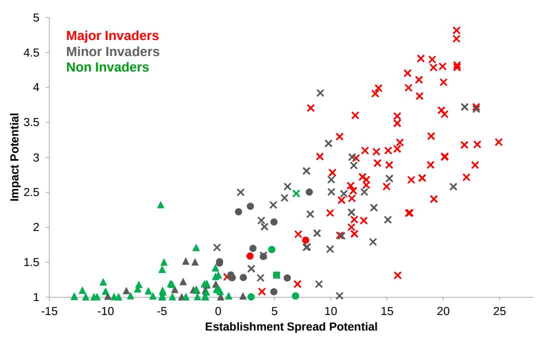
Uncertainty Analysis

The Predictive Model

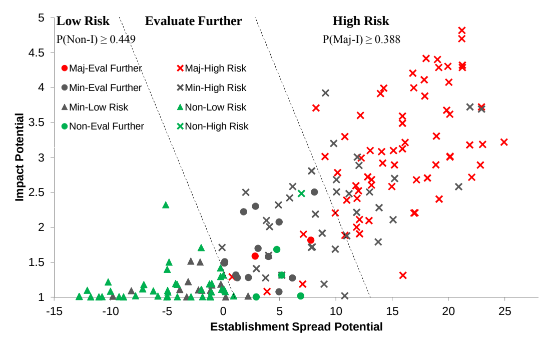
- Calculates Prob (invasiveness) using a logistic regression model

- P(Non-I) + P(Min-I) + P(Maj-I) = 1
- Developed & validated with 204 U.S. species

Risk Space



Risk Space



Model Performance

(validation dataset)

	Accuracy		Error	
Test	Maj-Invaders (True +)	Non-Invaders (True -)	Non-Invaders (False +)	Maj-Invaders (False-)
US – PPQ WRA	0.941	0.971	0.000	0.000
US - Aus WRA	0.971	0.794	0.088	0.000
Mean (8 other AUS tests)	0.936	0.715	0.164	0.022

- Overall accuracy is higher than the Australian WRA
- Non-invader and major-invader performance similar

Risk & Uncertainty

Uncertainty is a component of risk

A good PRA always documents uncertainty

Documenting uncertainty in the PPQ WRA

	Probability
Negl →	0.1%
Low →	1%
Mod →	10%
High →	25%
Max →	All answers equally likely

Uncertainty describes our confidence in our answers.
Expresses our belief that some other answer is correct.

Evaluate the sensitivity of a species' risk scores to uncertainty

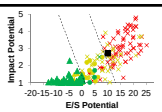
What would the final risk score be if we chose a different set of answers?

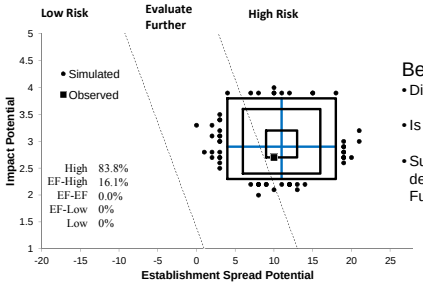
ES-8	Grass (y, n, or ?).	n	0	negl
ES-9	Nitrogen-fixing woody plant (y, n, or ?).	n	0	negl
ES-10	Produces viable seed or spores (y, n, or ?).	y	1	negl
ES-11	Self-compatible or apomictic (y, n, or ?).	n	-1	high
ES-12	Requires specialist pollinators (y, n, or ?).	n	0	mod
ES-13	Minimum generative time (A) less than 1 (multiple generations per year), (B) 1 year	?		max
ES-14	Prolific seed/spore production (see scoring	y	1	negl
ES-15	Propagules likely to be dispersed	y	1	negl
ES-16	Propagules likely to disperse as a produce	y	2	mod

Monte Carlo Simulation (@Risk)

- Randomly change answers based on the uncertainty level
- Calculate the new risk scores
- Determine the new result, and run secondary screening if necessary
- Repeat this 5000 times
- Plot and evaluate simulated risk scores

Example – *Rumex sagittatus*





Benefits
- Dig deeper?
- Is result robust?
- Suggests possible decision for Evaluate Furthers

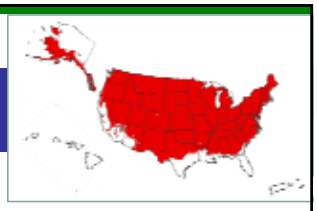
Climate – Geographic Potential

Climate

- Influences the success of colonizing species
- Climatic suitability in WRAs
  - Species adapted to climatic conditions receive higher risk scores

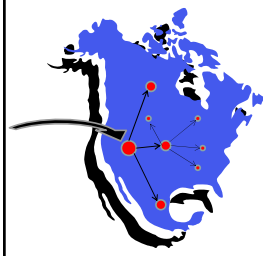
- Predictive WRA model does not include climatic suitability
  - The U.S. is very diverse
  - Climate suitability is evaluated separately using a *simple* climate matching tool

Geographic Potential



- Each WRA includes a predictive map
  - Joint the overlap of the 3 climatic variables
    - Cold hardiness, Annual precipitation, Köppen-Geiger climate class
- Calculate & report the percentage of the U.S. suitable for establishment
- Report the climatic profile

Entry Potential



- Entry – Movement of a pest into an area
- 14 questions (y/n, mult. choice)
  - Intentional
  - Unintentional
- Not necessary most of the time
- Useful for contaminants

The Final Product

- **Word/PDF document**
  - 12-15 page summary of results from Excel file
  - Always submitted to customers
- **Excel file**
  - Kept separate, but available upon request


USDA

Weed Risk Assessment for *Siderits montana* L. (Lamiaceae) – Mountain ironwort

The Final Product

- Background: Initiation, distribution, US status
- Narrative summary of risk elements
- Map of potential US distribution
- Results & conclusions
  - Risk score in relation to the 204 species
  - Graphical results of the uncertainty simulation
- Disscusion
- Literature Cited
- Appendix: excerpt of the Excel assessment

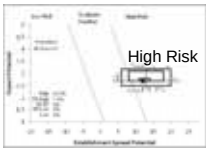
Completed WRAs

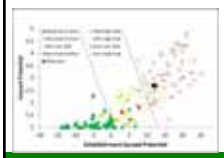
Taxon	Conclusion
Alpinia modesta	Low Risk
Artemisia austriaca	High Risk
Artemisia japonica	Evaluate Further
Praxelis clematidea	High Risk
Rhamnus alaternus	High Risk
Limnobium laevigatum	High Risk
Oplismenus hirtellus ssp undulatifolius	High Risk
Nymphoides cristata	High Risk
Mikania micrantha	High Risk
Syzygium australe	High Risk
Vitex rotundifolia	High Risk
Agrostis stolonifera	High Risk
Poa pratensis	High Risk
Falcaria vulgaris	High Risk
Nymphoides peltata	High Risk
Phyllostachys aurea	High Risk
Echinochloa pyramidalis	High Risk
Pilea hyalina	Evaluate Further

Taxon	Conclusion
Berberis glaucocarpa	High Risk
Luziola subintegra	High Risk
Persicaria capitata	Evaluate Further
Phyllanthus fluitans	High Risk
Rauvolfia vomitoria	High Risk
Acalypha australis	Evaluate Further
Althaea armeniaca	Low Risk
Hakea sericea	High Risk
Hippophae rhamnoides	High Risk
Solanum seaforthianum	High Risk
Achyranthes japonica	High Risk
Dipogon lignosus	High Risk
Neptunia oleracea	High Risk
Oxalis exilis	High Risk
Araujia sericifera	High Risk
Arundo donax	High Risk
Nymphoides indica	High Risk
Toona sinensis	High Risk

Completed=36; Development=5; Queue=47

Hippophae rhamnoides (Elaeagnaceae)





- Cultivated in the U.S., naturalized in 2 WY counties
- Become very invasive in Canadian prairies
- Forms dense thickets, N-fixer, alters natural habitats

Opportunities & Challenges in WRA

- Weeds won't wait
- Lots of plants out there
  - Plants that are here
  - Plants that are coming
- Limited Resources

Working Together

- What we can do for you
  - Do WRAs for some of your weeds
  - Inform you when we have completed WRAs
  - Train & mentor you to do your own WRAs
  - Provide literature information to support your efforts
- What you can do for us
  - Tell us about new and emerging weed threats
  - Identify weeds not yet in the U.S. that could be problematic
  - Collaborate on WRA projects (evidence, experts, review)

For more information or to submit requests for WRA

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Our Vision

To be globally recognized as a credible authority in weed risk assessment

The PPQ Weed Risk Assessment

Our Customers

- APHIS headquarters (e.g., Noxious Weed Program, Plants for Planting staff)
- Other Federal agencies (e.g., Forest Service, Fish & Wildlife Service, National Park Service)
- State and local governments
- Non-governmental organizations
- Any individual, group, or other "legal entity"

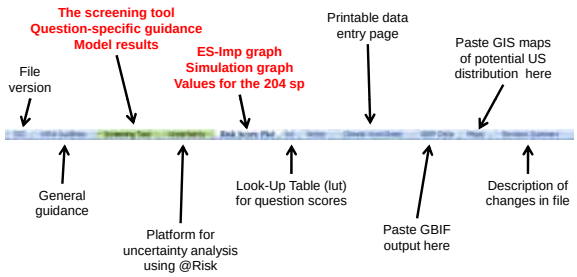
Our history with WRA

- **2005:** PERAL started doing WRA using a narrative process
- **2008:** Formed a team
  - began redesigning our WRA procedure
- **2010:**
  - Completed development
  - Assessing weeds and invasive plants
- **2011:** Published a paper
- **Sept 2011:** First WRA-101 training

Our history with WRA (cont.)

- **January 2012-present:**
  - Doing WRAs
  - Getting organized
  - Identifying team mission/vision/goals
  - Developing project management process
  - Launching team SharePoint site
- **May 2012:** ISO certification
- **June 2012:** second WRA 101 training

Platform: Microsoft Excel Workbook



Weed Risk Assessment

Pre-border Screening Tools

- Goal: Assess invasive and weedy potential (prediction)
- Traits: Behavior elsewhere, congeners, climatic compatibility, inherent species traits (invasiveness & impact)

Introduction → Escape → Naturalization → Spread → Impact

Post-border Charac. & Prioritization Tools

- Goal: Characterize current invasions to help prioritization
- Traits: Impacts, potential distribution, and feasibility of control

Sample Questions

- Establishment/Spread
  - Climbing or smothering growth habit?
  - Self-compatible or apomictic?
  - Propagules bird dispersed?
- Impact
  - Change community composition?
  - Change or limits recreational use of an area?
  - Reduce crop/product yield?

Summarizing uncertainty for each risk element

0 ⟷ 1
Uncertainty Index

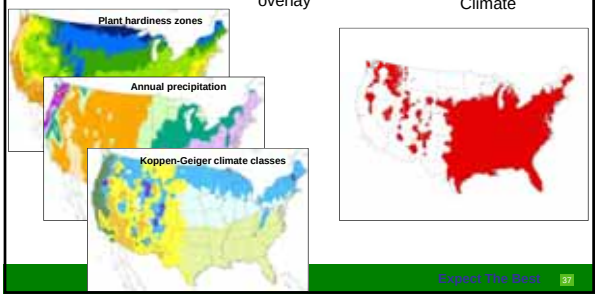
- Uncertainty level
  - (negl, low, mod, high, max)
- Question weighting
  - (e.g., ES: 0 to 10 points)

Species	E/S	Impact
A	0.18	0.20
B	0.20	0.03
C	0.17	0.10
D	0.22	0.36

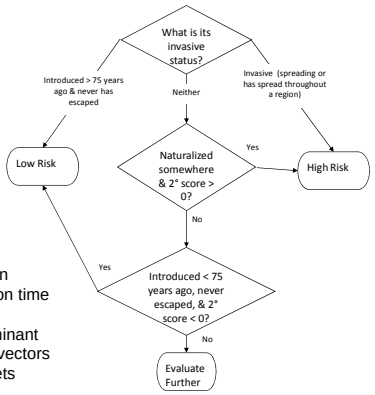
From our model validation (N=204) mean uncertainty = 0.17

Predictive pest risk mapping

Climate layers → In ArcGIS overlay → Similar Climate



Secondary Screening Tool

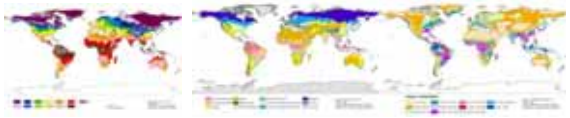


Secondary Score =
1) prolific reproduction
2) minimum generation time
3) shade adapted
4) commodity contaminant
5) No. nat. dispersal vectors
+ 6) forms dense thickets

Predictive Model has been Published

Geographic Potential

Cold Hardiness Zones	Köppen-Geiger Climate Classes	10-inch Precip Bands
Zone 1 (below -50F or below -45.6C)	Tropical rainforest	0-10 inches (0-25 cm)
Zone 2 (-50 to -40F, or -45.6 to -40.0C)	Tropical savanna	10-20 inches (25-51 cm)
Zone 3 (-40 to -30F, or -40.0 to -34.4C)	Steppe	20-30 inches (51-76 cm)
Zone 4 (-30 to -20F, or -34.4 to -28.9C)	Desert	30-40 inches (76-102 cm)
Zone 5 (-20 to -10F, or -28.9 to -23.3C)	Mediterranean	40-50 inches (102-127 cm)
Zone 6 (-10F to 0F, or -23.3 to -17.8C)	Humid subtropical	50-60 inches (127-152 cm)
Zone 7 (0 to 10F, or -17.8 to -12.2C)	Marine west coast	60-70 inches (152-178 cm)
Zone 8 (10 to 20F, or -12.2 to -6.7C)	Humid continental warm summers	70-80 inches (178-203 cm)
Zone 9 (20 to 30F, or -6.7 to -1.1C)	Humid continental cool summers	80-90 inches (203-229 cm)
Zone 10 (30 to 40F, or -1.1 to 4.4C)	Subarctic	90-100 inches (229-254 cm)
Zone 11 (40 to 50F, or 4.4 to 10C)	Tundra	100+ inches (254+ cm)
Zone 12 (50 to 60F, or 10 to 15.6C)	Icecap	
Zone 13 (above 60F, or above		



Other Potential Risk Elements / Modules

- Feasibility of control
- Extent of current and potential range
- Extent of cultivation
- Biofuels
- GMOs & LMOs

Species Information

Initiation

Foreign distribution

U.S. distribution and status

1. Analysis Results:

Establishment/Spread Potential

Text summary

Risk score

Impact Potential

Uncertainty index

1. Analysis Results

Geographic Potential

Text summary and U.S. map (Figure 1)

Text summary (and risk score and uncertainty index, if applicable)

Entry Potential

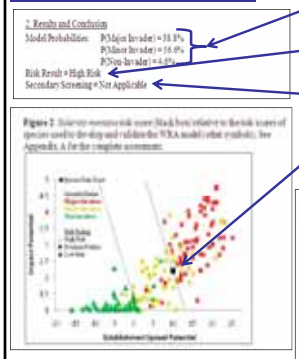
2. Results and Conclusion

Model probabilities for Major, Minor, and Non-Invader

Risk score (High Risk, Evaluate Further, or Low Risk)

Secondary Screening result (if applicable)

Figure 2. Risk score (■) relative to species used to develop the model



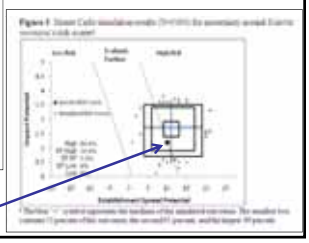


Figure 3. Shows effect of uncertainty on the risk score (■)

3. Discussion

Summary and discussion of overall results of assessment

- Includes effect of uncertainty on final conclusion
- May include additional information that may be useful for risk managers

4. Literature Cited

Appendix A

- Excerpt of the Excel risk assessment
- For each *question*, provides:
  - *answer* and *uncertainty rating*
  - *risk score*
  - *evidence*